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FLOOD INSURANCE STUDY

TOWN OF HARTLAND, VERMONT
WINDSOR COUNTY

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JUNE 15, 1988

COMPLETED

Federal Emergency Management Agency

COMMUNITY NUMBER - 500149

ORIGINAL

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program (NFIP) have established repositories of flood hazard data for floodplain management and flood insurance study purposes. This Flood Insurance Study (FIS) may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

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FLOOD INSURANCE STUDY
TOWN OF HARTLAND, WINDSOR COUNTY, VERMONT

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the Town of Hartland, Windsor County, Vermont, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were prepared by Dufresne-Henry, Inc., for the Federal Emergency Management Agency (FEMA), under Contract No. EMW-84C-1597. This work was completed in July 1986.

1.3 Coordination

In April 1984, an initial Consultation and Coordination Officer's (CCO) meeting was held with representatives from FEMA, the town, and Dufresne-Henry, Inc. (the study contractor), to determine the streams to be studied by detailed methods. The Town of Hartland, the U. S. Army Corps of Engineers (COE), the Vermont Agency of Transportation, and the Vermont Department of Water Resources all provided information pertinent to this study.

On April 15, 1987, the results of the study were reviewed at a final CCO meeting held with representatives from FEMA, the town, the study contractor, and the Vermont Department of Water Resources.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the Town of Hartland, Windsor County, Vermont. The area of study is shown on the Vicinity Map (Figure 1).

The following streams were studied by detailed methods: the Connecticut River, for its entire length within the community; the Ottauquechee River (Lower Reach), from its confluence with the Connecticut River to U. S. Route 5; the Ottauquechee River (Upper Reach), for its entire length within the community; and Lulls Brook, from Old Mill Dam to approximately 0.5 mile above Brownsville Road. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction through July 1991.

The following streams were studied by approximate methods: Babcock Brook, Harlow Brook, Fulling Brook, Cady Brook, Weed Brook, Alder Meadow Brook, McArthur Brook, Densmore Brook, North Hartland Reservoir, and a portion of Lulls Brook and the Ottauquechee River. Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and the Town of Hartland.

2.2 Community Description

The Town of Hartland is centrally located on the east side of Windsor County, approximately 9 miles south of White River Junction and approximately 29 miles east of the City of Rutland, in central Vermont. The total land area of the town is 44.6 square miles. It is bordered by the Town of Hartford to the north; the Town of Woodstock to the west; the Towns of Windsor and West Windsor to the south; the Town of Plainfield, New Hampshire, to the east; and the City of Lebanon, New Hampshire, to the northeast. In 1980, the population of the town was 2,396, a 33 percent increase over the 1970 population of 1,803 (References 1, 2, and 3).

The Connecticut River originates in northern New Hampshire and flows south forming the Vermont-New Hampshire border. The Connecticut River has a drainage area of 4,300 square miles at the Hartland-Hartford corporate limits. The Ottauquechee River originates in the Town of Sherburne and flows in an eastern direction to its confluence with the Connecticut River. It has a drainage area of 220 square miles at the North Hartland Dam. Lulls Brook rises in the hills near the corporate limits of the Towns of Woodstock, West Windsor, and Reading and flows in an eastern direction to its confluence with the Connecticut River. It has a drainage area of 22.5 square miles at the Old Mill Dam.

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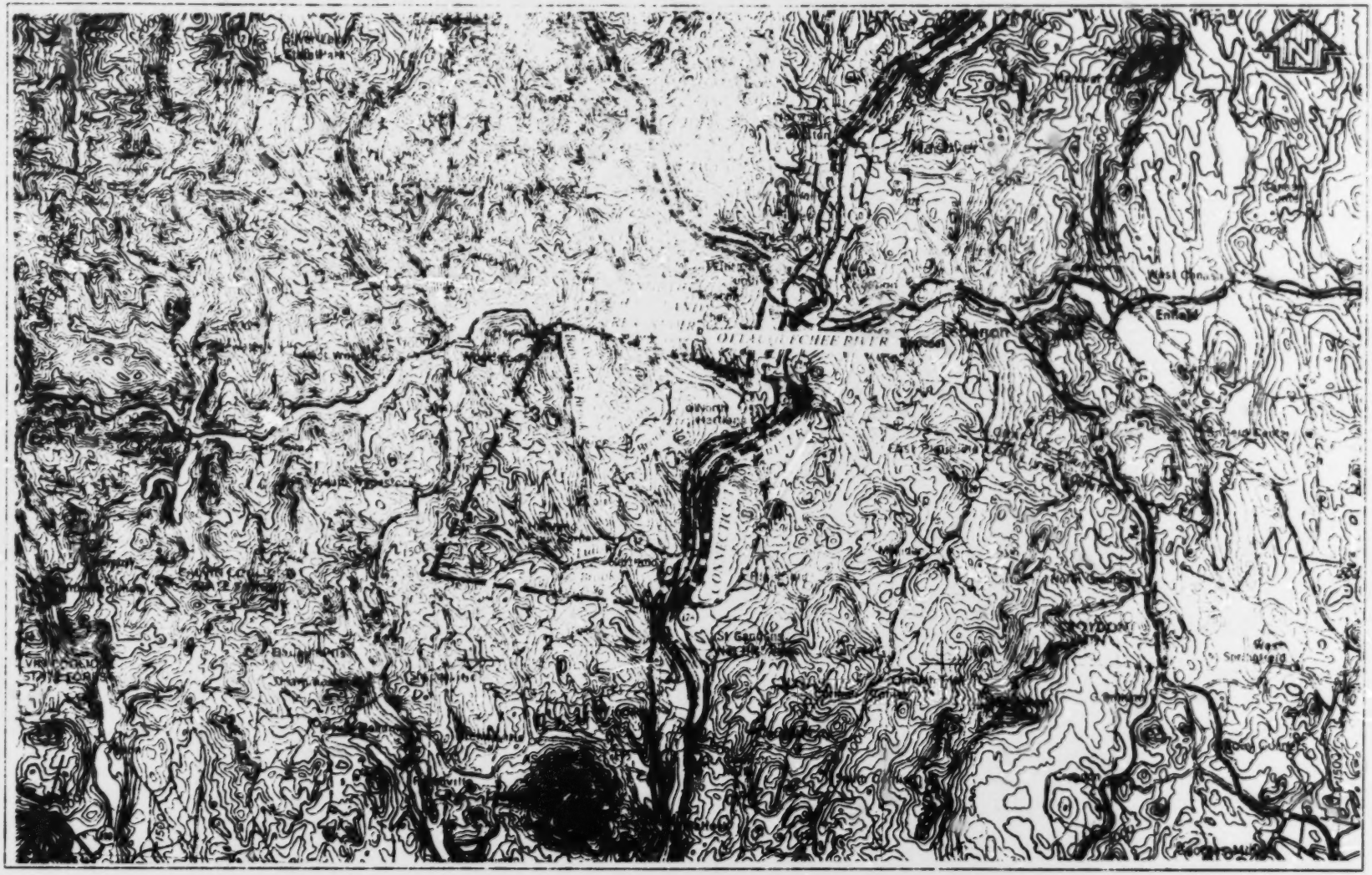

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF HARTLAND, VT

(WINDSOR CO.)

APPROXIMATE SCALE

4 0 4 8 12 MILES

VICINITY MAP

The climate in Hartland is continental with warm summers and cold winters. Average annual precipitation is approximately 43 inches and average annual snowfall is approximately 85 inches (Reference 4). Precipitation is evenly distributed throughout the year.

The topography is generally hilly except for the floodplains of the Connecticut River and the Ottauquechee River below the North Hartland Dam. The soils along the floodplain of the Connecticut River, the Ottauquechee River, and the lower portion of Lulls Brook are silty, sandy, and gravelly, which is typical of soils found in terraces and old lake plains. Floodplain soils in the upper portions of Lulls Brook are loamy. These upland soils are typically shallow and may have hardpan or bedrock within 3 feet (Reference 5).

2.3 Principal Flood Problems

Many significant floods have occurred on the Connecticut River. In Water-Supply Paper 1779-M, 14 floods were recalled on the Connecticut River between 1770 and 1936 in White River Junction or Bellows Falls. Of these, the 1927 flood is thought to be the most severe, followed in order by those in 1936, 1862, 1895, 1869, and 1913. Some of these floods, such as the 1936 flood, were a result of ice jams that can occur in Hartland at Sumner Falls and Harts Island. Development along the Connecticut River in Hartland is sparse, thus damage from even very large floods is minimal. Residences south of the confluence of the Ottauquechee River may experience flood damage from the Connecticut River in the future.

Floods have occurred on the Ottauquechee River in 1811, 1824, 1828, 1869, 1927, 1936, 1938, and 1973. Of these, the 1927 flood was probably the most severe followed by floods in 1973, 1869, 1828, and 1824. The most severe damage in North Hartland occurred in 1824 when several bridges and mill dams were destroyed. The North Hartland area is now protected from the Ottauquechee River flooding by the COE North Hartland Dam.

Flooding may have occurred in the past on Lulls Brook; however, Town of Hartland Annual Reports for 1927 and 1936 make no mention of damage resulting from floods in those years. Local residents do recall high water on Lulls Brook in 1973, but documentation as to the extent of flooding was not found.

2.4 Flood Protection Measures

The COE owns and operates two flood control dams that reduce flood discharges in Hartland. Union Village Dam on the Ompomponoosuc River is capable of reducing Connecticut River flood peaks by approximately 5 percent for the stream length above the confluence of the Ottauquechee River in Hartland. North Hartland Dam on the Ottauquechee River approximately 1 mile above the mouth reduces peak discharges downstream of the Connecticut River by approximately 10 percent. Together the two COE dams are operated to desynchronize

flood peaks on the tributaries from the uncontrolled portion of the watershed achieving a 15 percent reduction. The North Hartland Dam virtually eliminates significant flood discharges below the dam on the Ottauquechee River. For example, the July 1973 flood-peak discharge from the dam was limited to 4,800 cubic feet per second (cfs). The COE estimated that without the dam a discharge of 31,000 cfs would have occurred, similar to what occurred in November 1927 (Reference 6). There are no flood protection measures existing or proposed on Lulls Brook.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied in detail affecting the community.

Discharges on the Connecticut River were based on data developed by the COE (Reference 7).

Discharges for the Ottauquechee River (Lower Reach) and the Ottauquechee River (Upper Reach) were obtained from data supplied by the COE for the Flood Insurance Study for the Town of Hartford (Reference 8). Discharges below the North Hartford dam are the maximum the COE would expect to release during a flood of the selected recurrence interval. Discharges above the dam are based on a log-Pearson Type III analysis of peak discharges at the USGS Ottauquechee River gage in North Hartland for the period 1928 to 1974 taken from the Flood Insurance Study for the Town of Hartford

(Reference 8). Discharges after 1960 were adjusted for the effects of the North Hartland Dam. The results of this analysis were then transposed to points of interest upstream.

Peak-flood discharges for Lulls Brook are an average of four regional methods and transposition from the results of statistical analysis from two nearby USGS gages with comparable drainage areas (References 9, 10, 11, 12, and 13).

A summary of the drainage area-peak discharge relationships for the streams studied by detailed methods is shown in Table 1, "Summary of Discharges."

TABLE 1 - SUMMARY OF DISCHARGES - FREE FLOWING FLOODS

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
CONNECTICUT RIVER					
At downstream corporate limits	4,700	70,500	100,700	117,500	159,400
OTTAUQUECHEE RIVER (LOWER REACH)					
At confluence with Connecticut River	223[1]	7,000	7,000	8,000	10,000
OTTAUQUECHEE RIVER (UPPER REACH)					
Above confluence of Whitman Brook[2]	197	14,115	25,860	32,800	55,160
LULLS BROOK					
At Old Mill Dam	22.5	2,000	3,525	4,350	7,200
Above confluence of unnamed brook at Mace Hill Road	19.4	1,780	3,170	3,900	6,100
Above confluence of Alder Meadow Brook	16.0	1,625	2,920	3,600	5,600
Above confluence of Weed Brook	12.4	1,260	2,275	2,800	4,700

[1] 220 square miles controlled by North Hartland Dam
[2] Located outside corporate limits

Winter discharges used for ice jam analyses on the Connecticut River were chosen based on discharges that were gaged at the White River Junction USGS gage and other tributary gages during ice jam floods in 1936, 1977, and 1979. It was assumed that the 1936, 1977, and

1979 events have recurrence intervals of approximately 100, 50, and 10 years, respectively.

A summary of the drainage area-peak discharge relationships for the Connecticut River is shown in Table 2, "Summary of Discharges - Ice Jam Floods."

TABLE 2 - SUMMARY OF DISCHARGES - ICE JAM FLOODS

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
CONNECTICUT RIVER					
At downstream corporate limits	4,700	40,000	50,000	60,000	70,000

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Cross sections for the Connecticut River were taken from the Flood Insurance Study for the Town of Plainfield (Reference 14). Cross sections for the Ottauquechee River (Lower Reach), the Ottauquechee River (Upper Reach), and Lulls Brook were obtained by aerial photographs at a scale of 1:2,400 with a contour interval of 5 feet (Reference 15). Cross sections for the Ottauquechee River below the North Hartland Dam and Lulls Brook were supplemented by field surveys and bridge plans. Above the dam, cross sections were also taken from the Flood Insurance Study for the Town of Hartford (Reference 8).

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross-section locations are also shown on the Flood Insurance Rate Map (Exhibit 2).

Water-surface elevations of floods of the selected recurrence intervals were computed using the COE HEC-2 step-backwater computer program (Reference 16). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals. Starting water-surface elevations for the Connecticut River were taken from the Flood Insurance Study for the Town of Windsor (Reference 17). Starting water-surface elevations for the Ottauquechee River (Lower Reach) were assumed to be concurrent with peak elevations on the Connecticut River. Starting water-surface elevations for the Ottauquechee River (Upper Reach) were taken from

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the Flood Insurance Study for the Town of Hartford (Reference 8). Starting water-surface elevations for Lulls Brook were started at critical depth at Old Mill Dam.

Channel and overbank roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgment based on field observations of the river and floodplain area and compared with Water-Supply Paper 1849 and Hydraulic Design Series No. 4 (References 18 and 19). Channel "n" and overbank "n" values for the streams studied by detailed methods are shown in the following tabulation:

Stream	Channel "n"	Overbank "n"
Connecticut River	0.032 - 0.035	0.060 - 0.250
Ottauquechee River (Lower Reach)	0.035 - 0.040	0.040 - 0.090
Ottauquechee River (Upper Reach)	0.035 - 0.040	0.040 - 0.090
Lulls Brook	0.035 - 0.040	0.050 - 0.080

Ice jams were analyzed based on experienced flood elevations associated with ice jam events at several locations along the Connecticut River. The most definitive source of data was the record of stages obtained by New England Power Company (NEPCO) at the Cornish covered bridge approximately 3.5 miles downstream of Windsor. In Hartland, tree scars at Sumner Falls provided clear evidence of repeated ice jams and a reasonably accurate record of stages. NEPCO descriptions of ice conditions at various locations between Wilder and Bellows Falls were also useful in piecing together the timing and mechanics of recent ice jams. Finally, high-water marks for the 1936 flood as well as newspaper accounts of the timing and stages of that flood provided additional data. Ice thickness and location were then used with the water discharges for the selected recurrence intervals to calibrate the HEC-2 ice jam models with historical stages.

Flood elevations for free flowing and ice jams for each recurrence interval, for each cross section, were used to determine combined stage frequency curves along the Connecticut River.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in this study are shown on the maps; the descriptions of the marks are presented in Elevation Reference Marks (Exhibit 3).

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4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. Therefore, each Flood Insurance Study provides 100-year flood elevations and delineations of the 100- and 500-year floodplain boundaries and 100-year floodway to assist communities in developing floodplain management measures.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For the streams studied in detail, the 100- and 500-year floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:2,400 with a contour interval of 5 feet (Reference 15).

For the streams studied by approximate methods, the 100-year flood boundaries were delineated using the Flood Hazard Boundary Map for the Town of Hartland (Reference 20).

The 100- and 500-year floodplain boundaries are shown on the Flood Insurance Rate Map (Exhibit 2). On this map, the 100-year floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A and AE), and the 500-year floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 100- and 500-year floodplain boundaries are close together, only the 100-year floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

For the streams studied by approximate methods, only the 100-year floodplain boundary is shown on the Flood Insurance Rate Map (Exhibit 2).

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 100-year floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent

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floodplain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated for selected cross sections (Table 3). The computed floodways are shown on the Flood Insurance Rate Map (Exhibit 2). In cases where the floodway and 100-year floodplain boundaries are either close together or collinear, only the floodway boundary is shown. Portions of the floodway widths for the Connecticut River extend beyond the corporate limits.

The area between the floodway and 100-year floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 2.

Near the mouths of streams studied in detail, floodway computations are made without regard to flood elevations on the receiving water body. Therefore, "Without Floodway" elevations presented in Table 3 for certain downstream cross sections of the Ottauquechee River (Lower Reach) are lower than the regulatory flood elevations in that area, which must take into account the 100-year flooding due to backwater from other sources.

5.0 INSURANCE APPLICATION

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone.

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY	INCREASE
Connecticut River								
A	3,760[1]	465[3]	14,331	8.2	331.2[4]	330.0	331.0	1.0
B	7,145[1]	635[3]	19,726	6.0	332.6[4]	331.9	332.8	0.9
C	12,085[1]	603[3]	17,425	6.7	334.0[4]	333.1	333.9	0.8
D	16,335[1]	669[3]	19,617	6.0	335.4[4]	334.3	335.1	0.8
E	18,485[1]	528[3]	12,006	9.8	335.8[4]	334.9	335.7	0.8
F	19,235[1]	670[3]	16,775	7.0	337.7[4]	336.5	337.2	0.7
G	23,640[1]	725[3]	16,267	7.2	339.8[4]	338.6	339.1	0.5
H	27,575[1]	610[3]	17,418	6.7	341.3[4]	340.2	340.6	0.4
I	31,175[1]	567[3]	15,125	7.8	342.5[4]	341.3	341.8	0.5
J	38,025[1]	454[3]	14,161	8.3	344.8[4]	344.0	344.6	0.6
Ottauquechee River (Lower Reach)								
A	70[2]	327	1,832	4.4	342.8	325.8[5]	325.8	0.0
B	620[2]	201	1,082	7.4	342.8	326.0[5]	326.0	0.0
C	1,125[2]	239	1,294	6.2	342.8	327.0[5]	327.0	0.0
D	1,501[2]	336	1,715	4.7	352.6	352.6	352.6	0.0
E	1,883[2]	212	1,940	4.1	352.9	352.9	352.9	0.0
F	2,005[2]	212	1,791	4.5	352.9	352.9	352.9	0.0
G	2,300[2]	275	1,413	5.7	353.0	353.0	353.0	0.0
H	3,290[2]	223	1,346	5.9	354.9	354.9	354.9	0.0
I	4,280[2]	413	3,070	2.6	355.9	355.9	355.9	0.0

[1]Feet above corporate limits
[2]Feet above confluence with Connecticut River
[3]This width extends beyond corporate limits
[4]Elevation computed considering ice jam effects
[5]Elevation computed without consideration of backwater effects from Connecticut River

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF HARTLAND, VT

(WINDSOR CO.)

FLOODWAY DATA

CONNECTICUT RIVER - OTTAUQUECHEE RIVER (LOWER REACH)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Ottauquechee River (Lower Reach) (continued)								
J	5,610[1]	255	1,623	4.9	356.2	356.2	356.3	0.1
K	6,140[1]	587	3,640	2.2	356.8	356.8	356.9	0.1
L	6,360[1]	247	1,383	5.8	356.8	356.8	356.8	0.0
Ottauquechee River (Upper Reach)								
A	780[2]	203	2,931	11.2	629.1	628.1	628.2	0.1
B	1,915[2]	192	2,677	12.3		630.8	631.7	0.9
Lulls Brook								
A	155[3]	152	1,093	4.0	422.3	422.3	423.3	1.0
B	680[3]	233	1,181	3.7	423.1	423.1	424.0	0.9
C	1,200[3]	230	1,212	3.6	424.4	424.4	425.1	0.7
D	1,890[3]	250	958	4.5	425.8	425.8	426.5	0.7
E	2,410[3]	86	367	11.9	432.8	432.8	432.8	0.0
F	2,710[3]	44	295	14.8	448.9	448.9	448.9	0.0
G	3,785[3]	39	283	15.4	553.9	553.9	553.9	0.0
H	3,990[3]	53	313	13.9	562.6	562.6	562.6	0.0
I	4,495[3]	169	1,339	3.2	566.6	566.6	566.8	0.2
J	5,225[3]	170	469	9.3	569.5	569.5	569.5	0.0

[1]Feet above confluence with Connecticut River
[2]Feet from corporate limits
[3]Feet above Old Mill Dam

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY
TOWN OF HARTLAND, VT
(WINDSOR CO.)

FLOODWAY DATA

OTTAUQUECHEE RIVER (LOWER REACH) - OTTAUQUECHEE RIVER (UPPER REACH) - LULLS BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY	INCREASE
Lulls Brook (continued)								
K	6,350	430	1,655	2.6	572.9	572.9	573.8	0.9
L	6,695	450	1,653	2.6	573.2	573.2	574.2	1.0
M	7,200	230	915	4.8	574.0	574.0	574.9	0.9
N	7,570	214	648	6.7	575.3	575.3	576.0	0.7
O	8,575	171	956	4.6	579.2	579.2	580.0	0.8
P	9,135	92	411	10.6	581.0	581.0	581.3	0.3
Q	10,025	74	505	8.6	589.1	589.1	589.5	0.4
R	10,380	72	449	9.7	591.6	591.6	591.8	0.2
S	11,015	62	407	10.7	596.4	596.4	597.0	0.6
T	11,185	71	687	6.3	600.8	600.8	600.8	0.0
U	11,530	56	419	10.4	601.1	601.1	601.1	0.0
V	12,575	102	408	9.6	609.8	609.8	610.3	0.5
W	13,500	118	689	5.7	616.9	616.9	617.2	0.3
X	14,350	93	531	7.4	620.8	620.8	621.2	0.4
Y	14,935	55	339	11.5	624.6	624.6	624.7	0.1
Z	15,275	104	585	6.2	627.4	627.4	628.0	0.6
AA	15,680	84	542	6.6	629.4	629.4	629.7	0.3
AB	16,100	90	500	7.2	630.7	630.7	631.5	0.8
AC	16,245	105	875	4.1	636.3	636.3	636.9	0.6
AD	16,735	90	410	8.8	636.3	636.3	637.3	1.0
AE	17,725	97	470	7.7	646.0	646.0	646.0	0.0
AF	19,090	97	641	5.6	650.5	650.5	651.1	0.6

[1]Feet above Old Mill Dam

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF HARTLAND, VT

(WINDSOR CO.)

FLOODWAY DATA

LULLS BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Lulls Brook (continued)								
AG	20,050	122	530	6.8	654.1	654.1	655.1	1.0
AH	20,650	79	478	7.5	658.8	658.8	659.0	0.2
AI	20,855	75	514	7.0	661.7	661.7	661.7	0.0
AJ	21,345	81	401	9.0	663.2	663.2	664.1	0.9
AK	22,230	81	442	8.1	672.1	672.1	672.1	0.0
AL	22,730	85	506	7.1	675.1	675.1	675.1	0.0
AM	22,880	78	681	5.3	678.4	678.4	678.4	0.0
AN	23,305	104	559	6.4	678.9	678.9	679.3	0.4
AO	23,675	73	434	8.3	680.4	680.4	681.3	0.9
AP	24,235	87	454	7.9	683.2	683.2	683.8	0.6
AQ	24,550	115	644	4.3	685.3	685.3	685.6	0.3
AR	25,355	130	544	5.1	687.1	687.1	687.5	0.4
AS	25,530	123	700	4.0	689.0	689.0	689.8	0.8
AT	25,910	78	260	10.8	690.6	690.6	690.6	0.0

[1]Feet above Old Mill Dam

TABLE 3

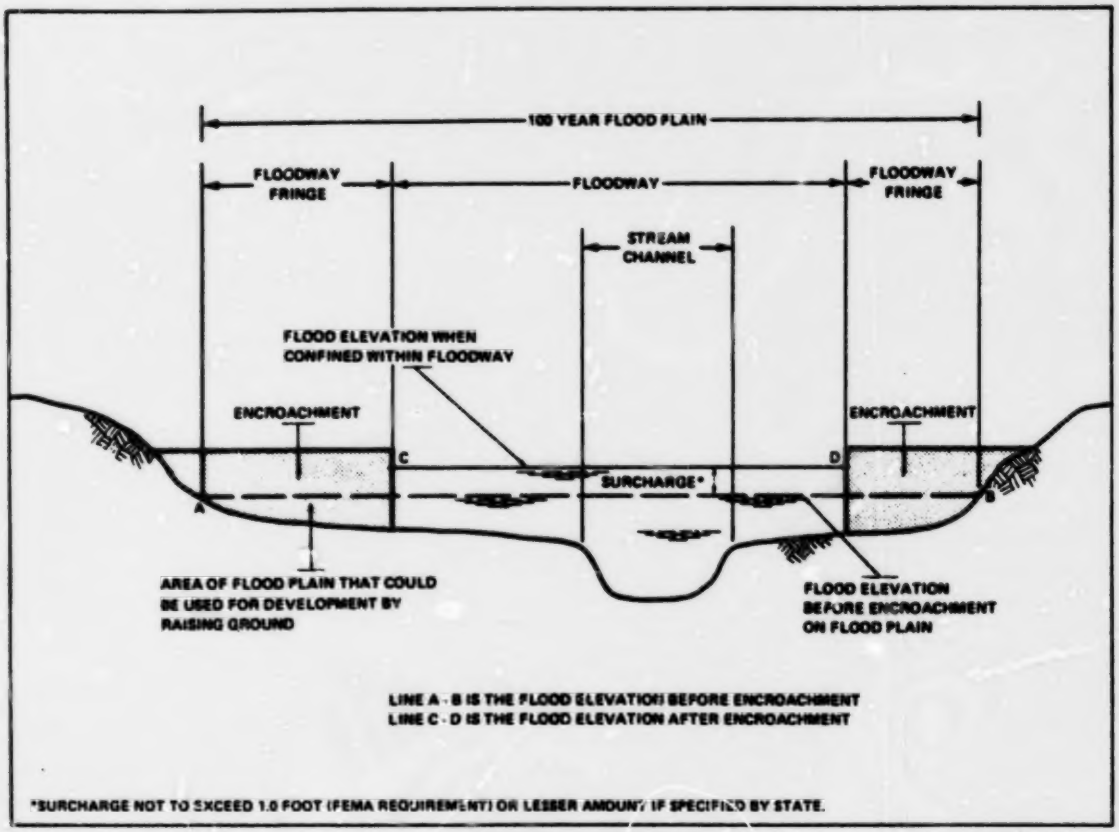
FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF HARTLAND, VT

(WINDSOR CO.)

FLOODWAY DATA

LULLS BROOK


100 YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE A - B IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE C - D IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

FLOODWAY SCHEMATIC

Figure 2

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by detailed methods. In most instances, whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AH

Zone AH is the flood insurance rate zone that corresponds to the areas of 100-year shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

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Zone AO

Zone AO is the flood insurance rate zone that corresponds to the areas of 100-year shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.

Zone A99

Zone A99 is the flood insurance rate zone that corresponds to areas of the 100-year floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No base flood elevations or depths are shown within this zone.

Zone V

Zone V is the flood insurance rate zone that corresponds to the 100-year coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are performed for such areas, no base flood elevations are shown within this zone.

Zone VE

Zone VE is the flood insurance rate zone that corresponds to the 100-year coastal floodplains that have additional hazards associated with storm waves. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 500-year floodplain, areas within the 500-year floodplain, and to areas of 100-year flooding where average depths are less than 1 foot, areas of 100-year flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 100-year flood by levees. No base flood elevations or depths are shown within this zone.

Zone D

Zone D is the flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.

6.0 FLOOD INSURANCE RATE MAP

The Flood Insurance Rate Map is designed for flood insurance and floodplain management applications.

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For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 100-year floodplains that were studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 100- and 500-year floodplains. Floodways and the locations of selected cross sections used in the hydraulic analyses and floodway computations are shown where applicable.

7.0 OTHER STUDIES

Flood Insurance Studies for the Towns of Plainfield and Woodstock, and the City of Lebanon have been published (References 14, 21, and 22). The results of this study are not in agreement with the results of the Plainfield and Lebanon studies for the Connecticut River because revisions to the ice jam analyses were made to better agree with historical data. In addition, ice jam and free-flowing flood elevations were then combined using a procedure that was not included in the FEMA guidelines at the time of these studies. This study does not agree with the results of the Woodstock study along the Ottauquechee River (Upper Reach) because this study uses more up-to-date data.

Flood Insurance Studies for the Towns of Windsor and Hartford are currently being prepared (References 23 and 8). The results of those studies will be in agreement with the results of this study.

Due to its more detailed nature, this study supersedes the Flood Hazard Boundary Map for the Town of Hartland (Reference 20).

8.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting FEMA, the Natural and Technological Hazards Division, J. W. McCormack Post Office and Courthouse Building, Room 462, Boston, Massachusetts 02109.

9.0 BIBLIOGRAPHY AND REFERENCES

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EXHIBIT 3 - ELEVATION REFERENCE MARKS

Reference Mark	FIRM Panel	Elevation (Feet NGVD)	Description of Location
RM 1	14	442.0	Standard tablet stamped 441 A55 in boulder, 15 feet north of dirt road, approximately 250 feet west of Boston and Main Railroad, near industrial park at Hartland Station.
RM 2	18	490.7	Vermont Department of Highways disk stamped CONT. 2 1 91-1 22 set in northeast corner of U. S. Route 5 bridge over Interstate Route 91, 1 foot above highway, 12.5 feet northwest of northeast end of metal guard rail, 17.5 feet north of centerline of highway, approximately 2.25 miles north from Hartland post office.
RM 3	19	410.5	Disk stamped B 58 1978 set in northeast corner abutment of U. S. Route 5 bridge over Boston and Maine Railroad, 1 foot above highway, 3.5 feet northeast of metal guard rail, 15 feet southeast of centerline of highway, 34 feet southwest of power pole number 66,250, approximately 4.45 miles north from Hartland post office.
RM 4	19	365.55	Standard disk stamped 365.457 C 6 1927 in top of west end of south abutment of Boston and Maine Railroad bridge over the Ottauquechee River, 20.9 feet west of west rail.

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EXHIBIT 3 - ELEVATION REFERENCE MARKS - continued

Reference Mark	FIRM Panel	Elevation (Feet NGVD)	Description of Location
RM 5	19	380.72	Brass disk stamped N.E.P.A. Bench Mark in top of southeast end of southeast concrete wing wall of U. S. Route 5 bridge over the Ottauquechee River, approximately 0.9 mile north of post office.
RM 6	10	664.2	Chiseled square on top of large rock outcrop, 93 feet southwest of intersection of U. S. Route 4 and State Route 12, approximately 0.6 mile southeast of Taftsville.
RM 7	14	585.7	Spike in powerpole #1/43 on north corner of triangular island at intersection of U. S. Route 5 and State Route 12.
RM 8	12	585.7	Nail set in power pole on north side of State Route 12, opposite Hartland Road Department.
RM 9	12	598.1	Chiseled square in southwest abutment of State Route 12 bridge over Lulls Brook, approximately 190 feet west of intersection of State Route 12 and Mace Road.
RM 10	12	632.1	Chiseled square in northwest abutment of State Route 12 bridge over Lulls Brook, approximately 300 feet east of intersection of State Route 12 and Brownsville Road.

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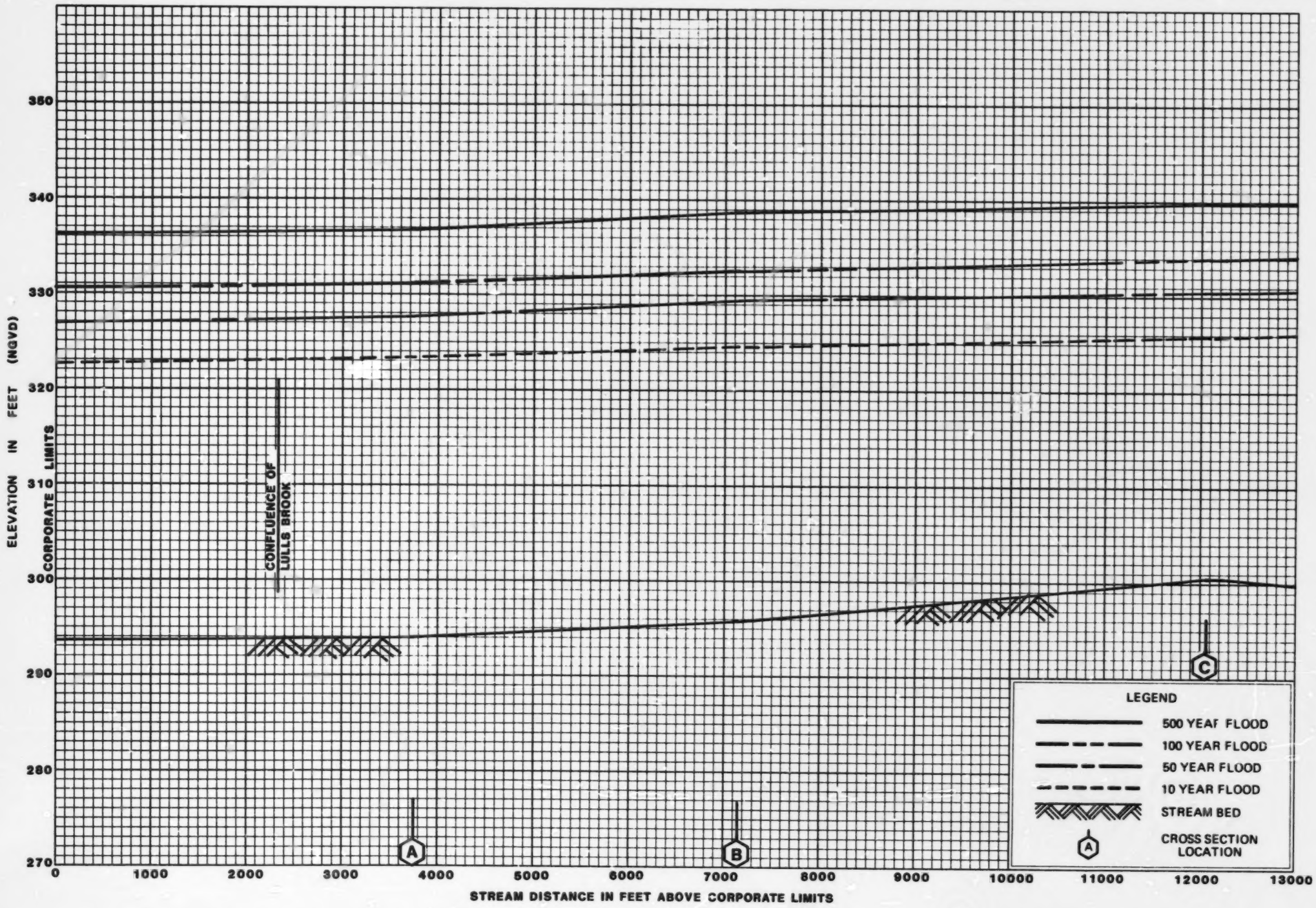
EXHIBIT 3 - ELEVATION REFERENCE MARKS - continued

Reference Mark	FIRM Panel	Elevation (Feet NGVD)	Description of Location
RM 11	12	632.4	Spike in power pole 9/123 on west side of Brownsville Road next to post office, approximately 100 feet north of intersection of State Route 12 and Brownsville Road.
RM 12	12	690.3	Spike in power pole #108 on east side of Brownsville Road, approximately 0.5 mile southwest of intersection of State Route 12 and Brownsville Road.
RM 13	12	665.8	Chiseled square in southeast corner of Brownsville Road bridge over Lulls Brook, approximately 0.1 mile northeast of intersection of Brownsville Road and County Road.
RM 14	12	682.5	Chiseled square in northwest corner of Brownsville Road bridge over Lulls Brook, approximately 0.14 mile east of intersection of Brownsville Road over Weed Road.
RM 15	12	693.9	Spike in power pole 912/12 just north of intersection of Brownsville Road and Weed Road.
RM 16	12	697.9	Spike in power pole 912/4A just west of intersection of Jenneville Road and Brownsville Road.



FLOOD PROFILES

CONNECTICUT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF HARTLAND, VT

(WINDSOR COUNTY)

01P

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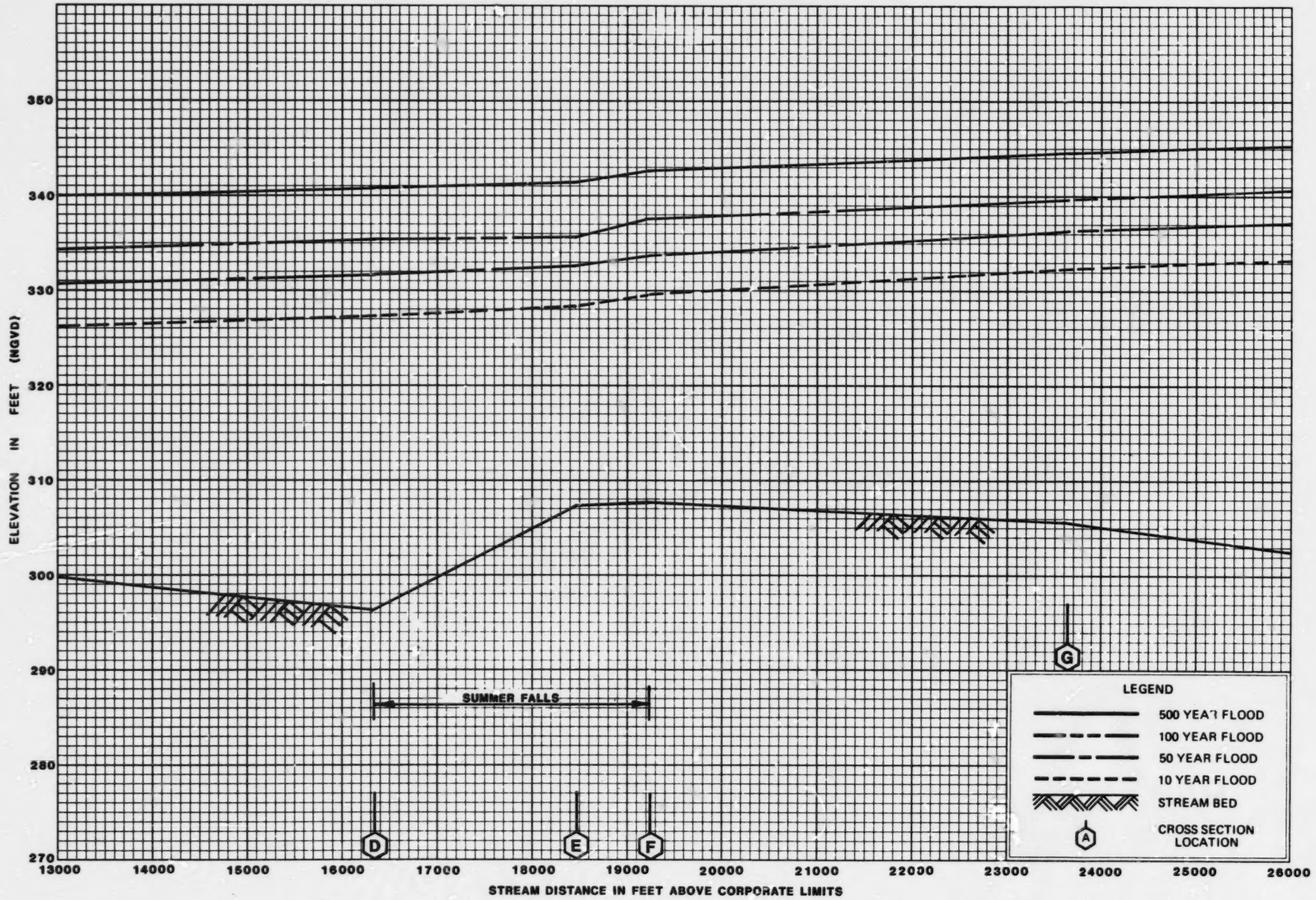

FLOOD PROFILES

CONNECTICUT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF HARTLAND, VT

(WINDSOR COUNTY)

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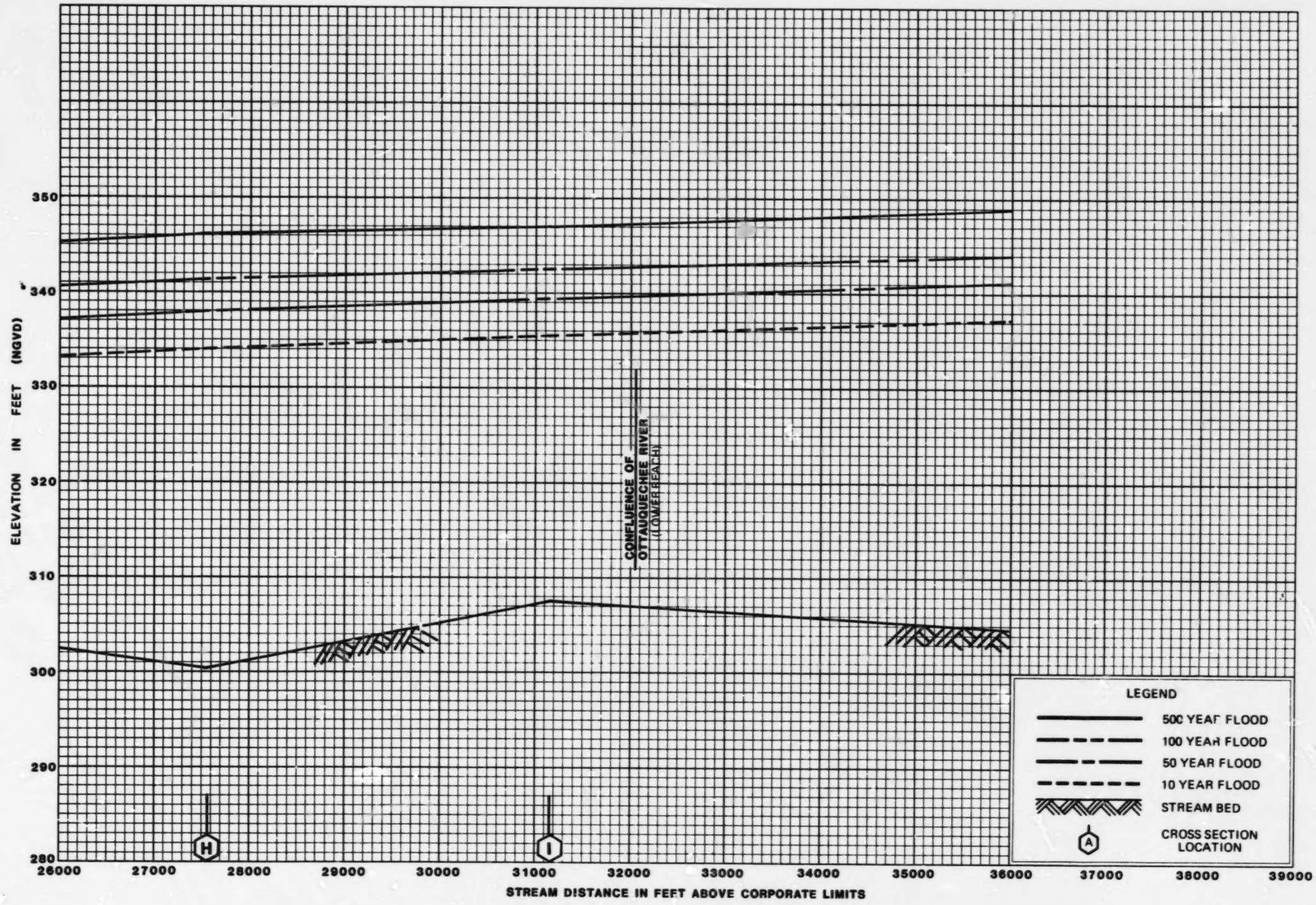

FLOOD PROFILES

CONNECTICUT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF HARTLAND, VT

(WINDSOR COUNTY)

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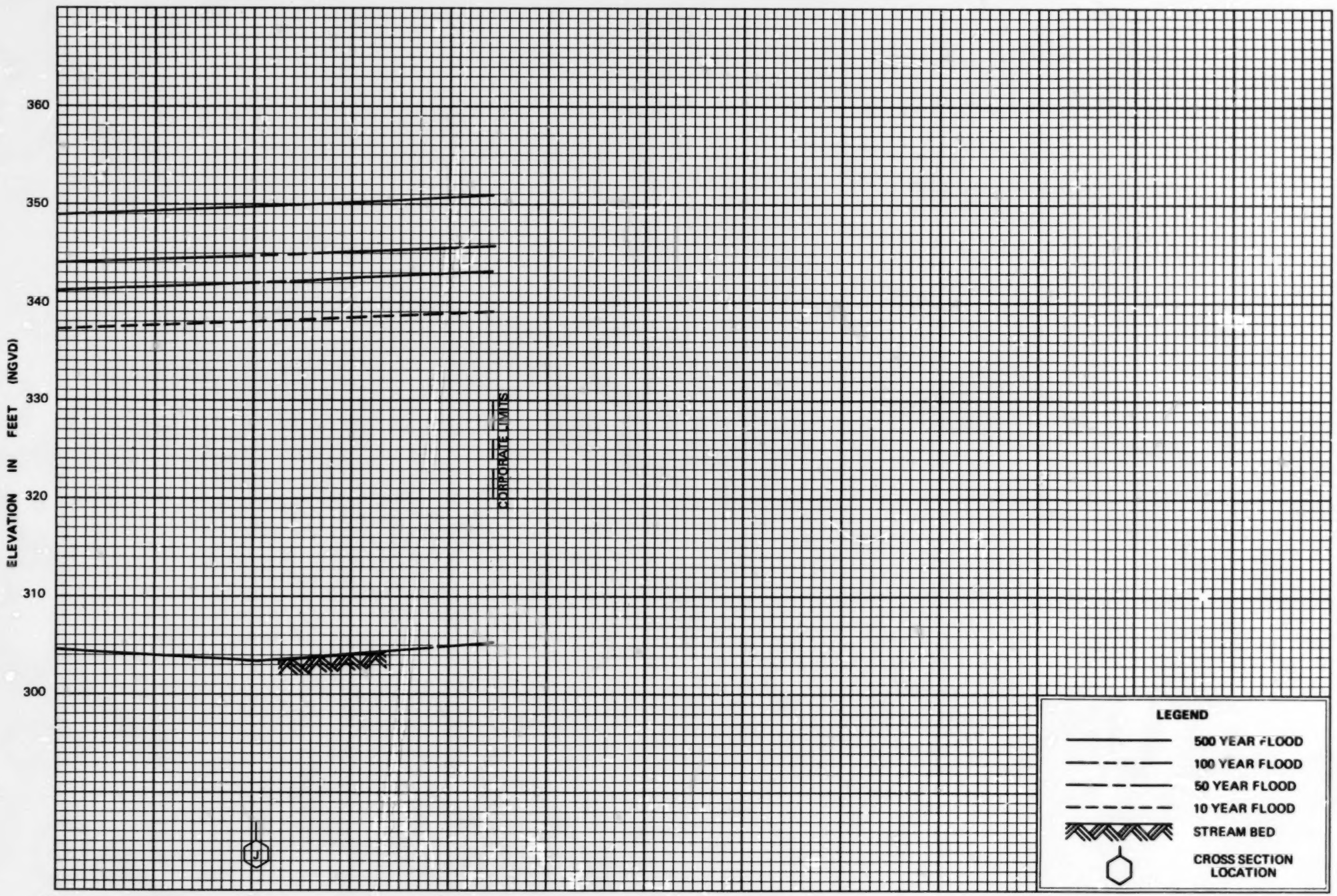

FLOOD PROFILES

CONNECTICUT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF HARTLAND, VT
(WINDSOR CO.)

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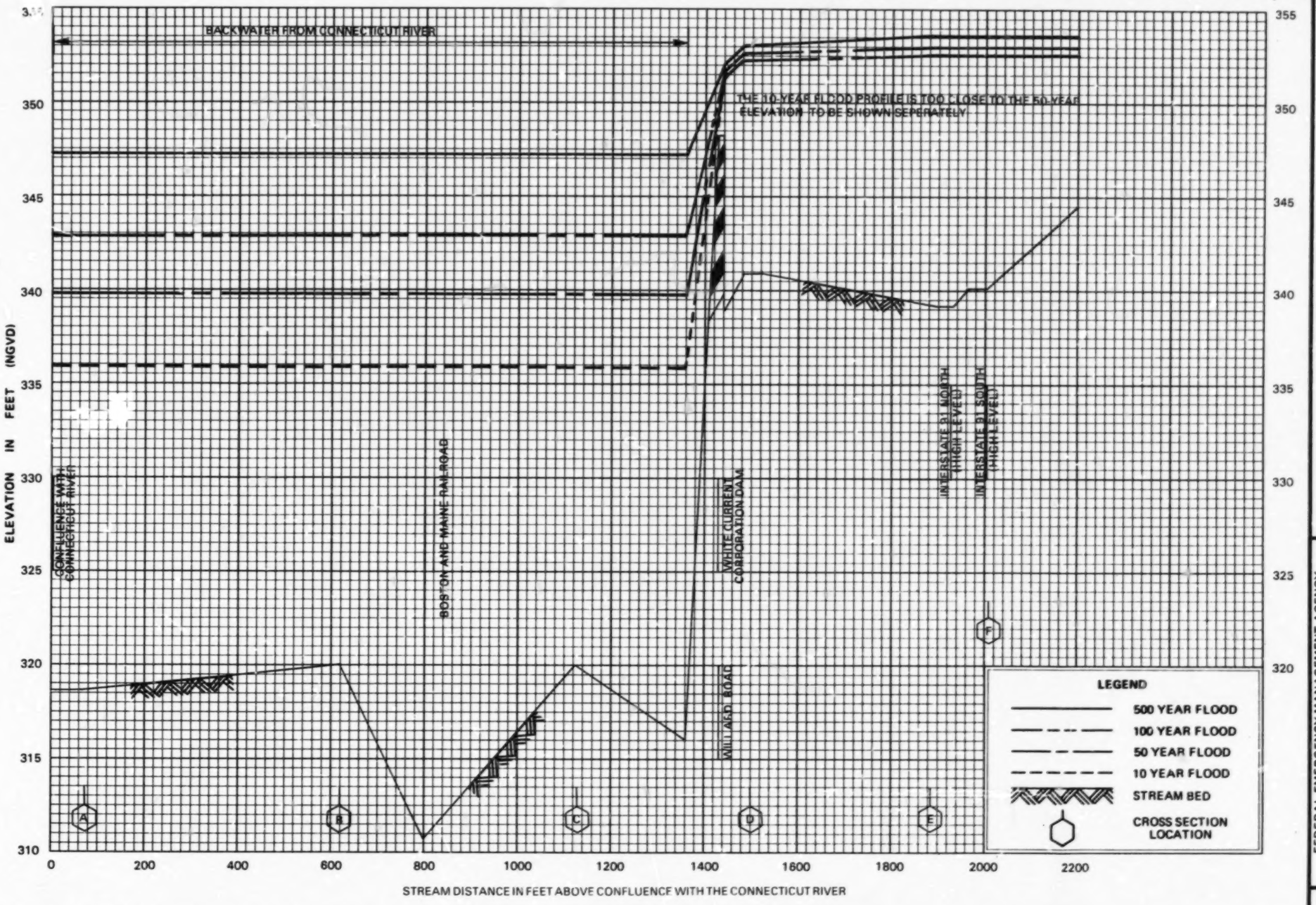

FLOOD PROFILES

OTTAUQUECHEE RIVER(LOWER REACH)

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF HARTLAND, VT

(WINDSOR CO.)

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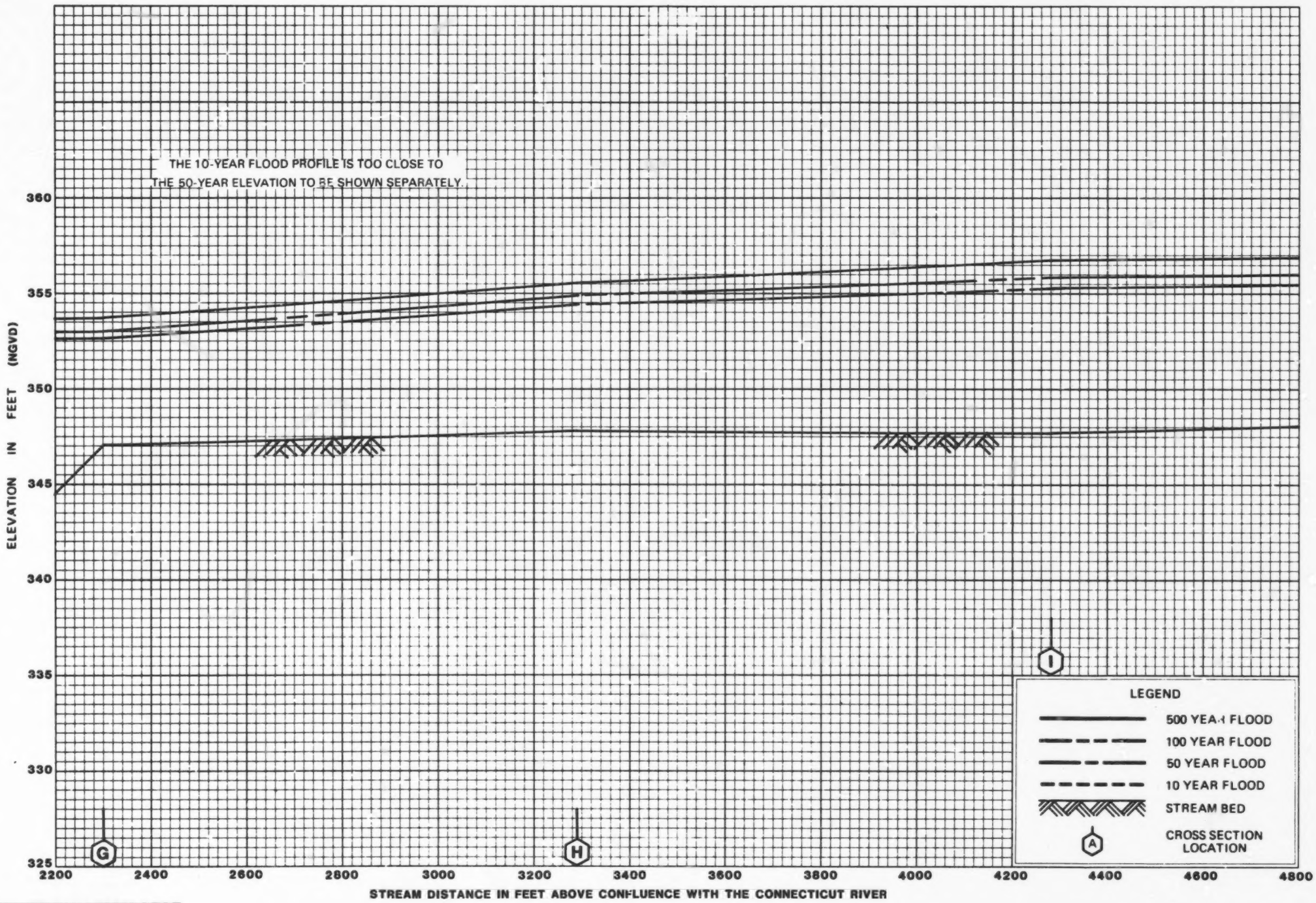

FLOOD PROFILES

OTTAUQUECHEE RIVER(LOWER REACH)

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF HARTLAND, VT

(WINDSOR COUNTY)

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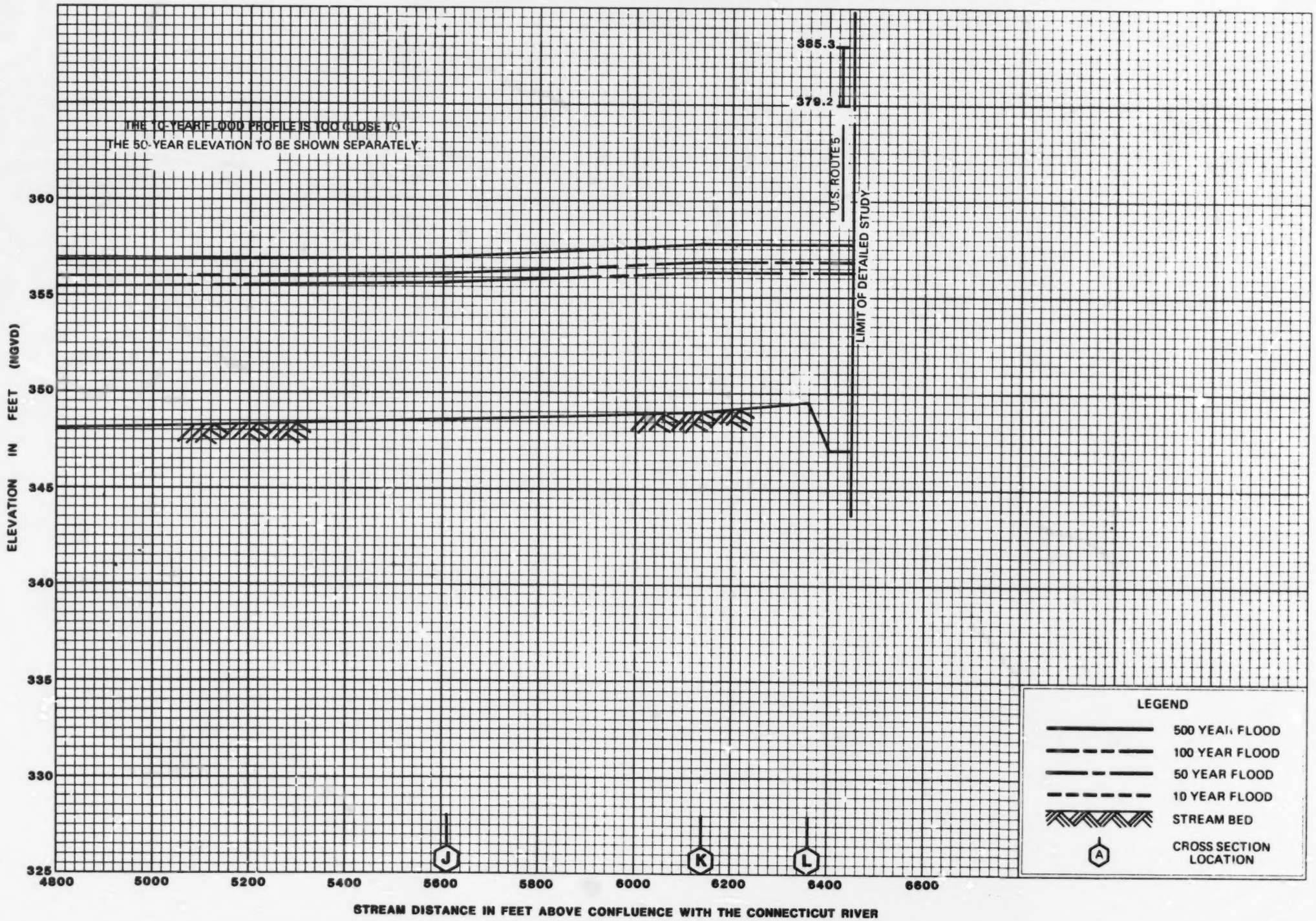

FLOOD PROFILES

OTTAUQUECHEE RIVER (LOWER REACH)

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF HARTLAND, VT

(WINDSOR COUNTY)

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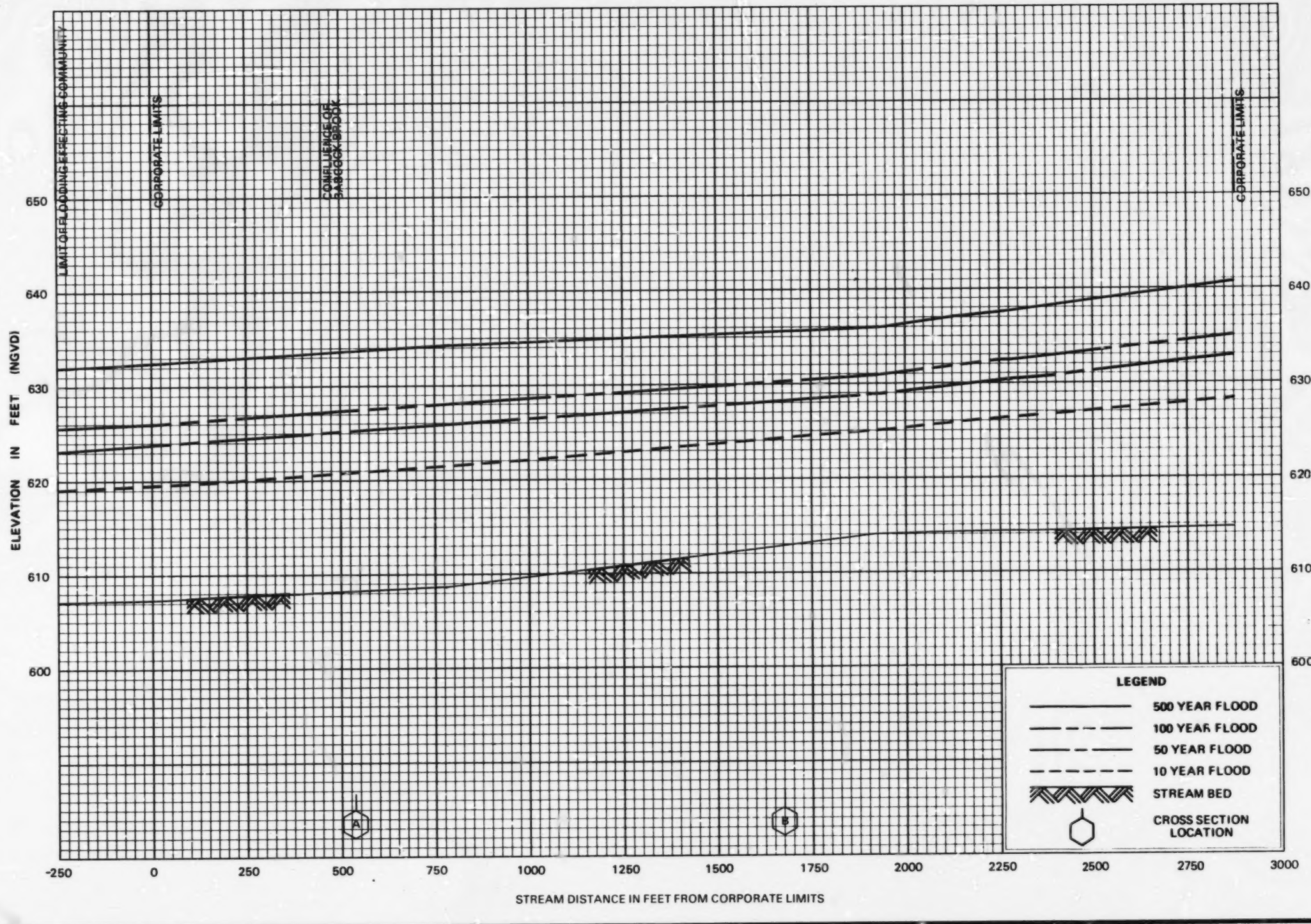

FLOOD PROFILES

OTTAUQUECHEE RIVER (UPPER REACH)

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF HARTLAND, VT

(WINDSOR CO.)

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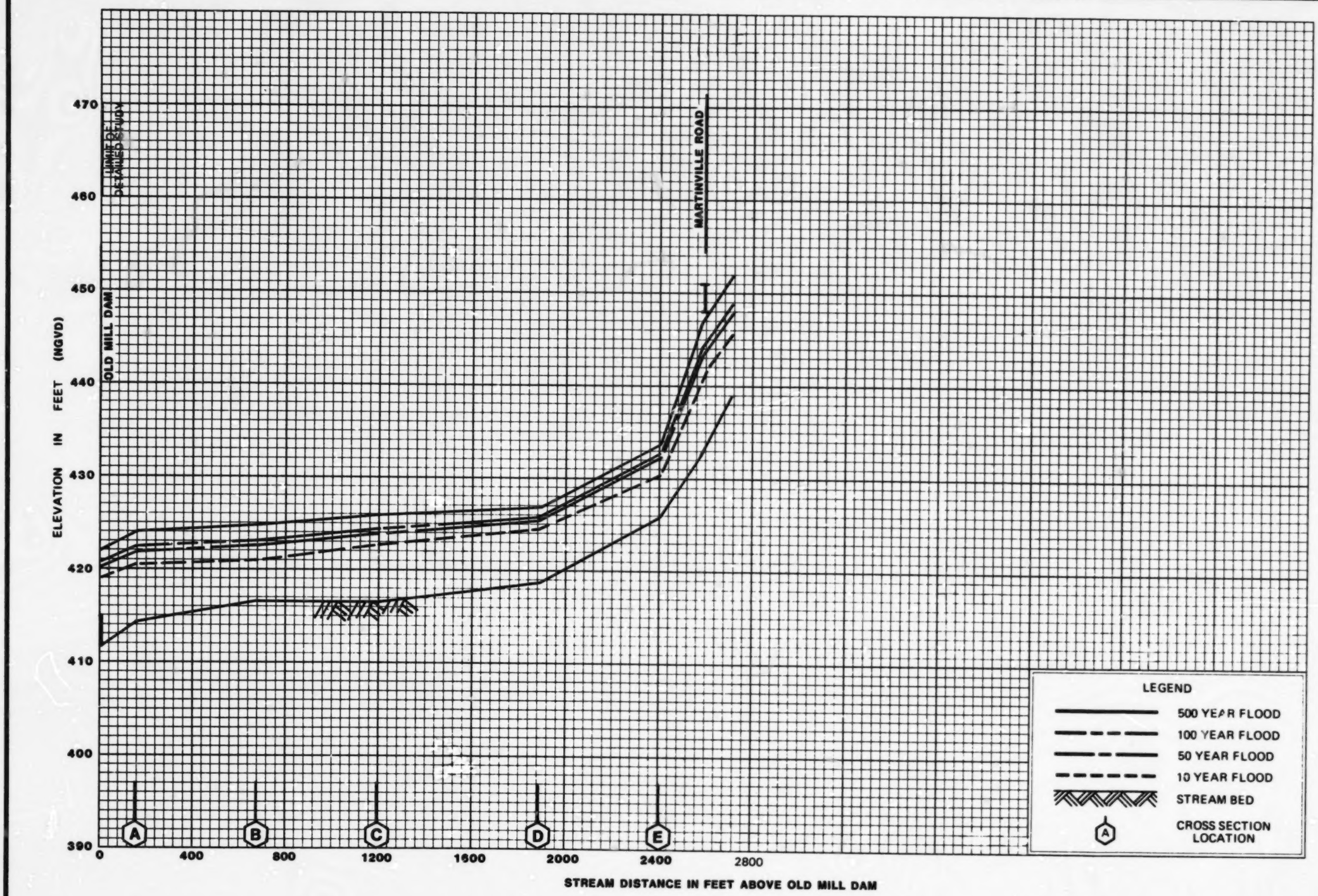

FLOOD PROFILES

LULLS BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF HARTLAND, VT.
(WINDSOR COUNTY)

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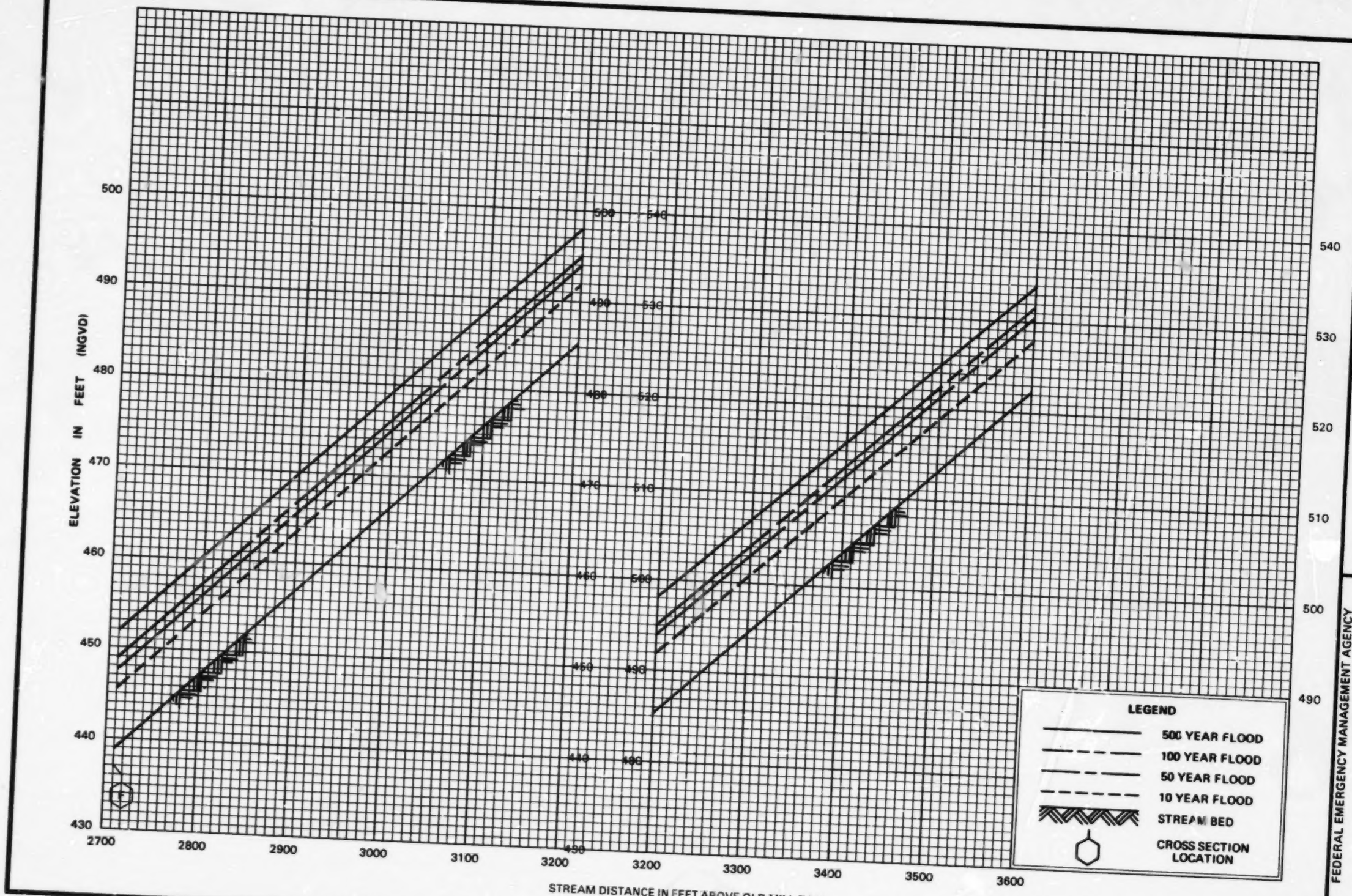

FLOOD PROFILES

LULLS BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF HARTLAND, VT

(WINDSOR CO.)

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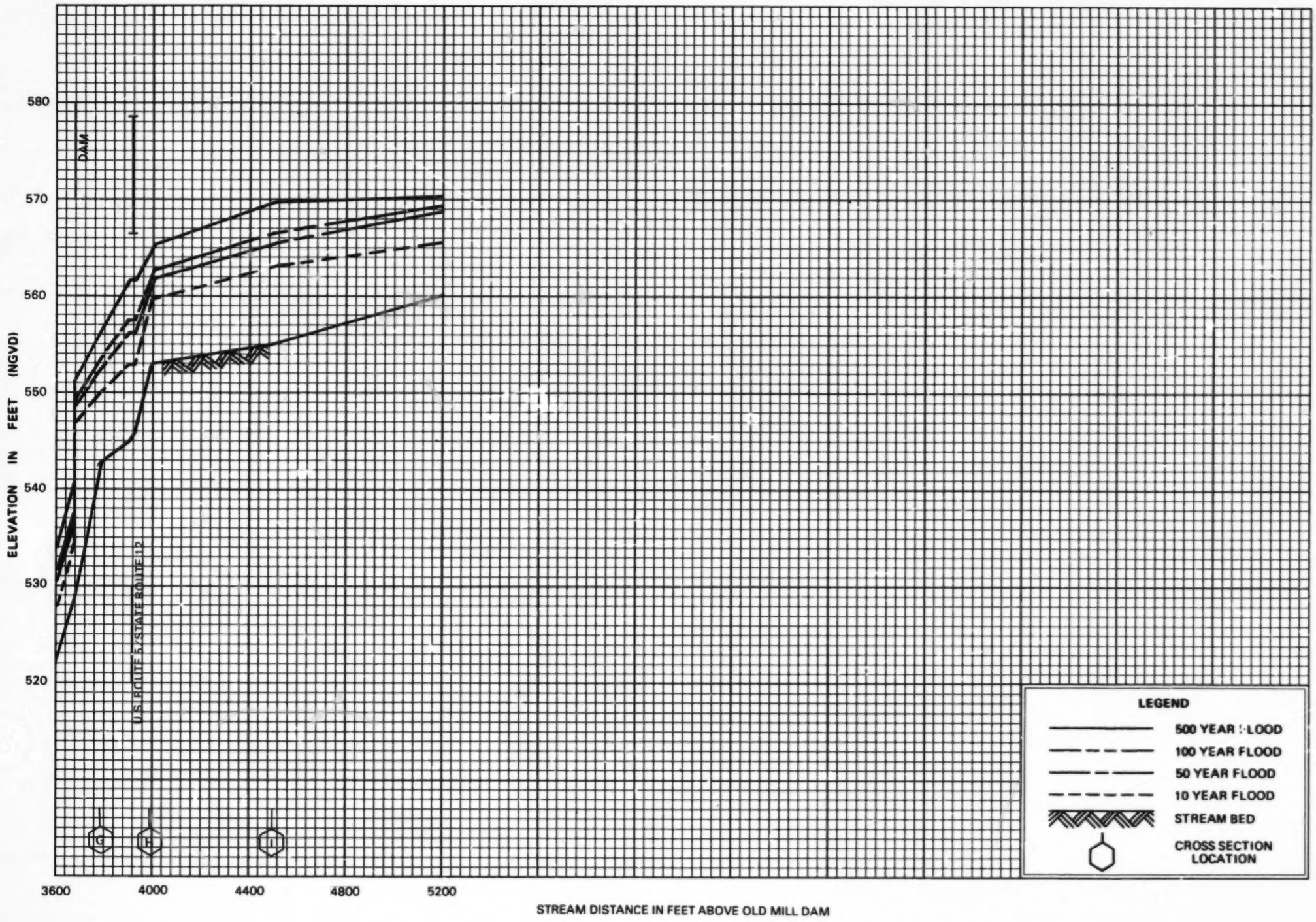

FLOOD PROFILES

LULLS BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF HARTLAND, VT
(WINDSOR CO.)

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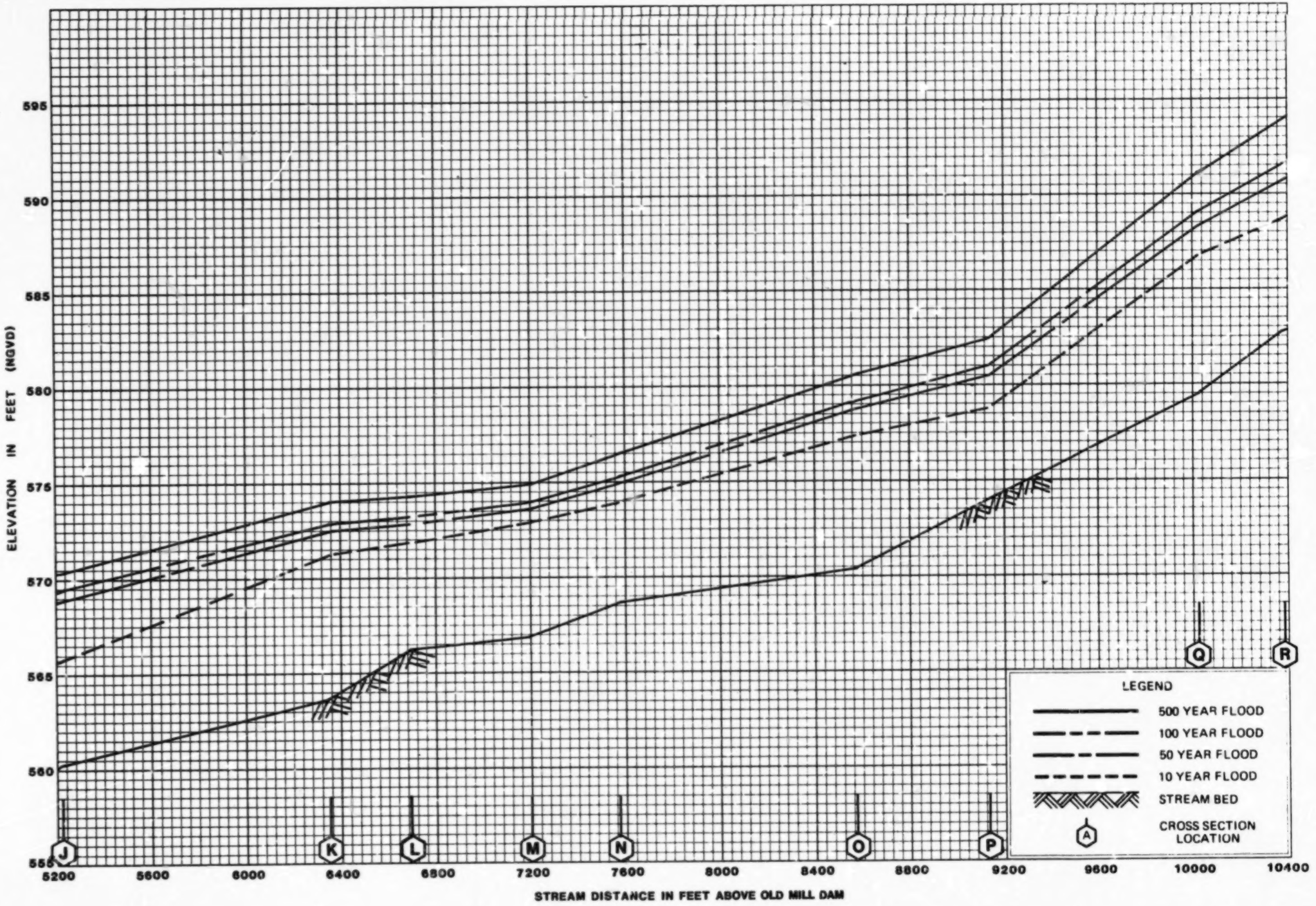

FLOOD PROFILES

LULLS BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF HARTLAND, VT

(WINDSOR CO.)

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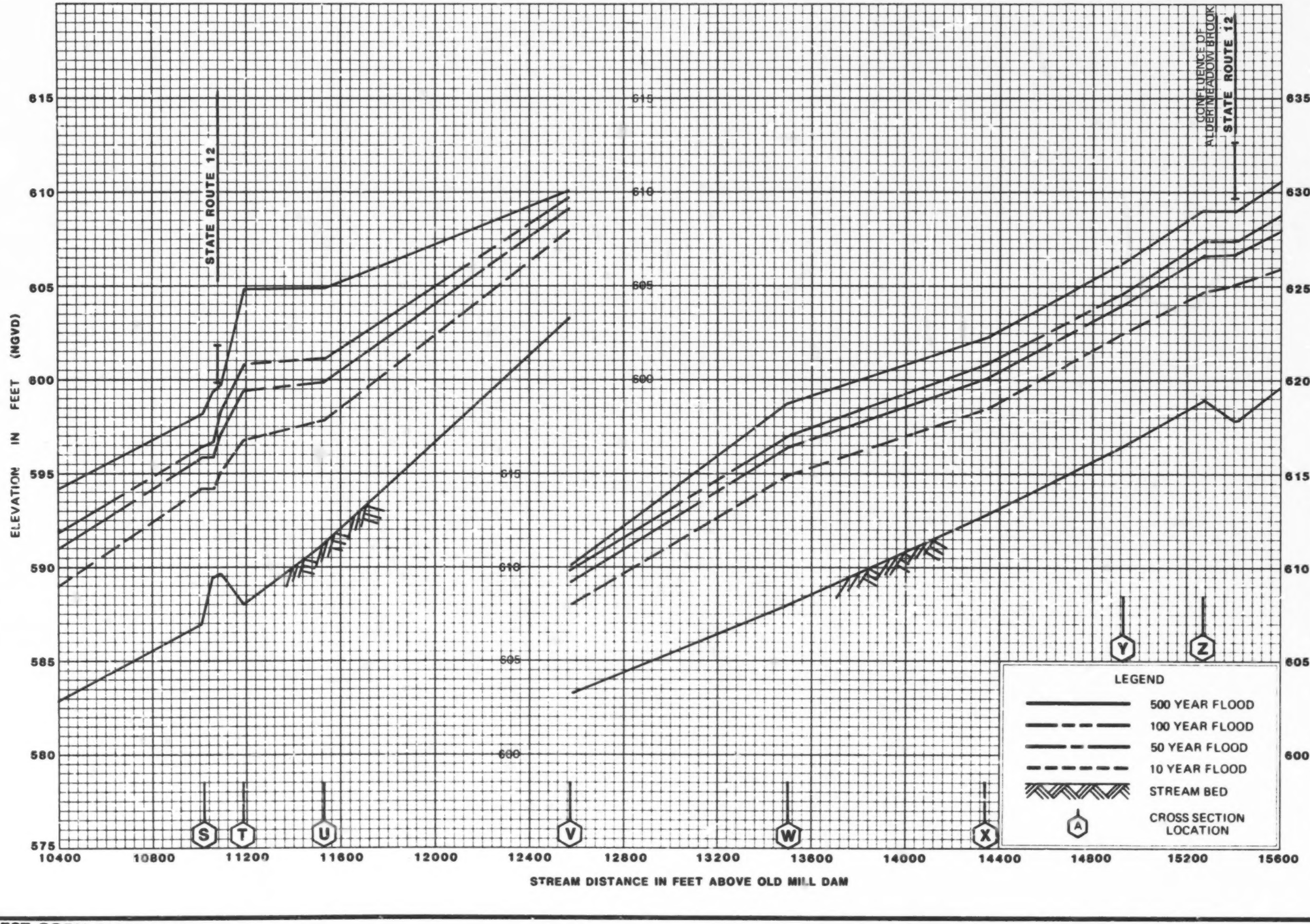

FLOOD PROFILES

LULLS BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF HARTLAND, VT

(WINDSOR CO.)

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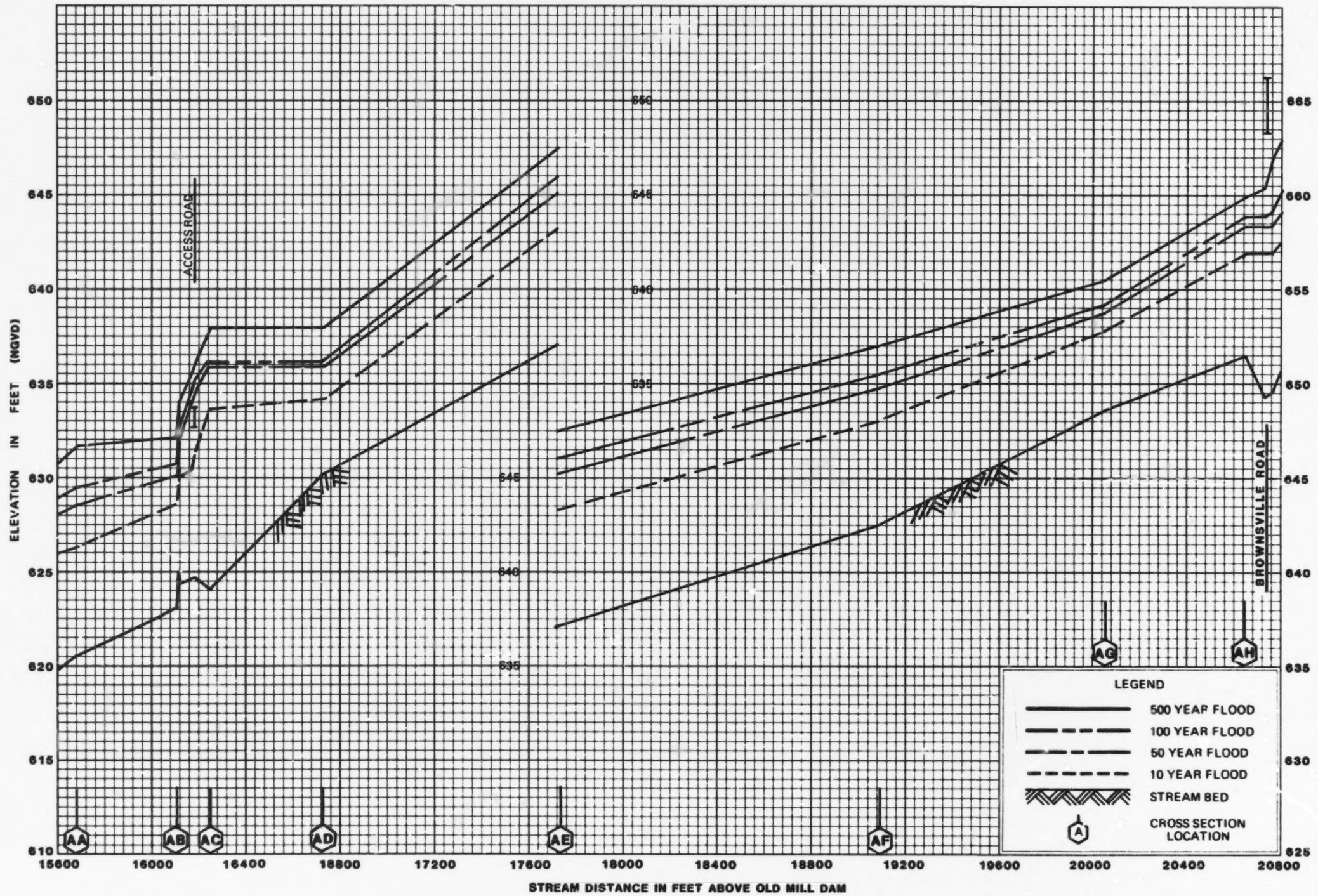

FLOOD PROFILES

LULLS BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF HARTLAND, VT
(WINDSOR CO.)

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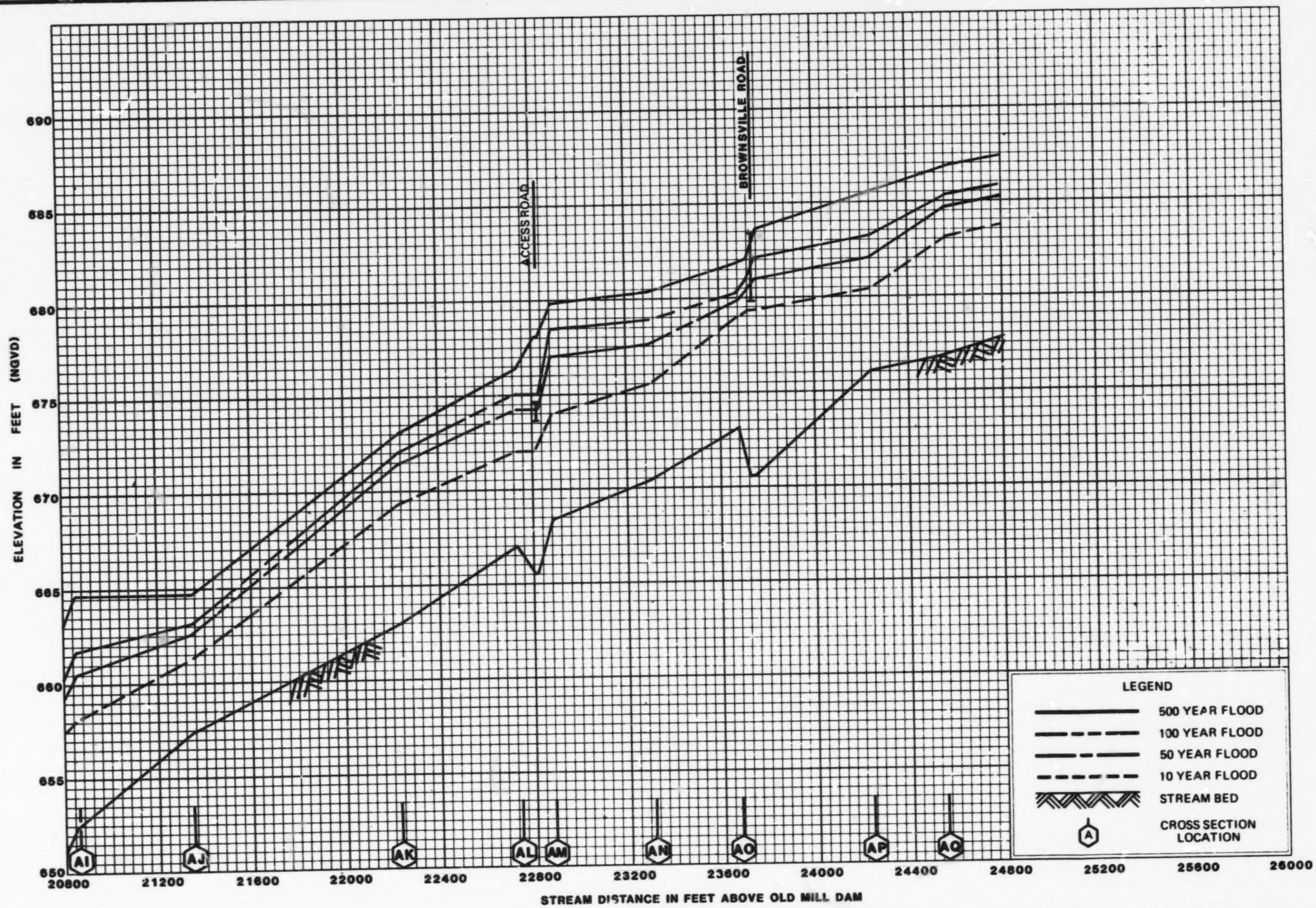

FLOOD PROFILES

LULLS BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF HARTLAND, VT

(WINDSOR CO.)

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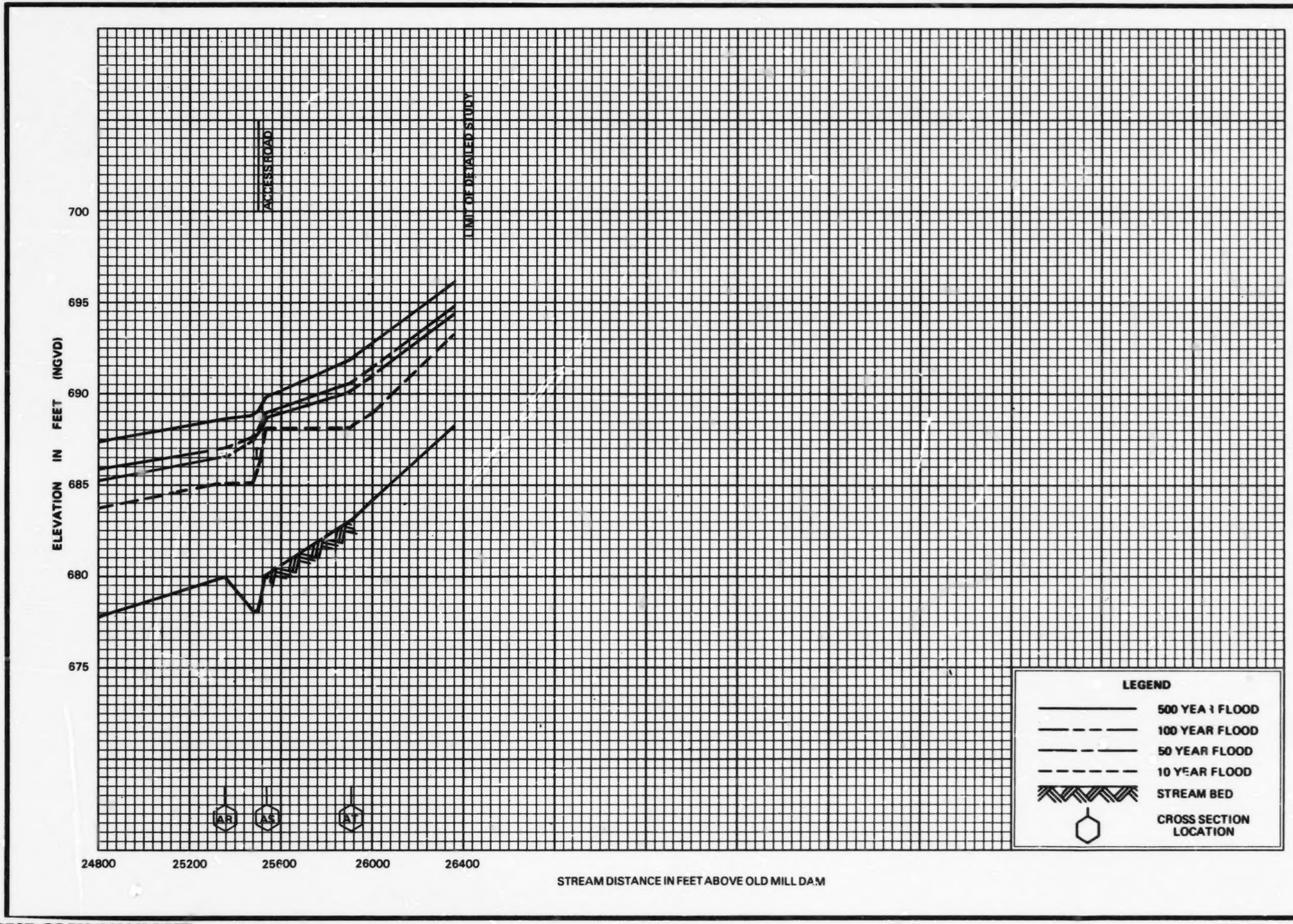

FLOOD PROFILES

LULLS BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF HARTLAND, VT
(WINDSOR CO.)

16P

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